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Ultra-high granularity electromagnetic calorimetry – Results from the EPICAL-2 prototype and perspectives for digital calorimeters

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A new type of SiW electromagnetic calorimeter is being developed using digital pixel sensors. The R&D is performed in the context of the FoCal upgrade within the ALICE experiment and is related to studies of imaging in proton CT; it is applicable to other future collider projects such as EIC, ILC, CLIC or FCC. Based on a proof of principle with a first digital calorimeter prototype, we have constructed an advanced second prototype, EPICAL-2, using ALPIDE MAPS sensors. Binary readout is possible due to the pixel size of $\approx 30 \times 30 \mu\text{m}^2$. The prototype consists of alternating W absorber and Si sensor layers, with a total thickness of $\sim 20 X_0$, an area of $30\text{mm} \times 30\text{mm}$, and ~ 25 million pixels. It has been successfully tested with cosmic muons and with test beams at DESY and the CERN SPS. First results have been published in [1], showing good energy resolution and linearity.

We will report on recent updates of performance results and comparisons to detailed MC simulations. The spatial precision of event-by-event measurements of the showers allows unprecedented studies of the shower shape, providing unique feedback to GEANT developers. The detector also features two-shower separation capabilities at extremely small distances. Further studies include a three-dimensional parameterisation of showers and electron/photon discrimination from hadrons. We will also discuss the limitations of the currently used sensor technology and perspectives for future development of digital calorimetry.

[1] J.Alme et al 2023 JINST 18 P01038

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